NORTH ATLANTIC TREATY ORGANIZATION
ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD

NATO STANDARDIZATION AGENCY (NSA)
AGENCE OTAN DE NORMALISATION (AON)
1110 BRUSSELS

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See CNAD AC/310 STANAG distribution

STANAG 4368 PPS (EDITION 2) – ELECTRIC AND LASER IGNITION SYSTEMS FOR ROCKETS AND GUIDED MISSILE MOTORS SAFETY DESIGN REQUIREMENTS

Reference:
a. AC/310-D/160, dated 17th November 1998
b. MAS/84-PPS/4368 dated 16 February 1998 (Edition 1)

1. The enclosed NATO Standardization Agreement which has been ratified by nations as reflected in page (iii) is promulgated herewith.

2. The references listed above are to be destroyed in accordance with local document destruction procedures.

3. AAP-4 should be amended to reflect the latest status of the STANAG.

ACTION BY NATIONAL STAFFS

4. National staffs are requested to examine page (iii) of the STANAG and, if they have not already done so, advise the Defence Support Division through their national delegation as appropriate of their intention regarding its ratification and implementation.

Jan H ERIKSEN
Rear Admiral, NONA
Director, NSA

Enclosure:
STANAG 4368 (Edition 2)

STANAG No. 4368
(Edition 2)

NORTH ATLANTIC TREATY ORGANIZATION
(NATO)

NATO STANDARDIZATION AGENCY
(NSA)

STANDARDIZATION AGREEMENT
(STANAG)

SUBJECT: ELECTRIC AND LASER IGNITION SYSTEMS FOR ROCKETS AND GUIDED MISSILE MOTORS SAFETY DESIGN REQUIREMENTS

Promulgated on 25 February 2002

Jan H ERIKSEN
Rear Admiral, NONA
Director, NSA

RECORD OF AMENDMENTS

No.	Reference/date of amendment	Date entered	Signature

EXPLANATORY NOTES

AGREEMENT

1. This NATO Standardization Agreement (STANAG) is promulgated by the Director, NSA under the authority vested in him by the NATO Military Committee.

2. No departure may be made from the agreement without consultation with the tasking authority. Nations may propose changes at any time to the tasking authority where they will be processed in the same manner as the original agreement.

3. Ratifying nations have agreed that national orders, manuals and instructions implementing this STANAG will include a reference to the STANAG number for purposes of identification.

DEFINITIONS

4. Ratification is "In NATO Standardization, the fulfilment by which a member nation formally accepts, with or without reservation, the content of a Standardization Agreement" (AAP-6).

5. Implementation is "In NATO Standardization, the fulfilment by a member nation of its obligations as specified in a Standardization Agreement" (AAP-6).

6. Reservation is "In NATO Standardization, the stated qualification by a member nation that describes the part of a Standardization Agreement that it will not implement or will implement only with limitations" (AAP-6).

RATIFICATION, IMPLEMENTATION AND RESERVATIONS

7. Page (iii) gives the details of ratification and implementation of this agreement. If no details are shown it signifies that the nation has not yet notified the tasking authority of its intentions. Page (iv) (and subsequent) gives details of reservations and proprietary rights that have been stated.

FEEDBACK

8. Any comments concerning this publication should be directed to NATO/NSA - Bvd Leopold III, 1110 Brussels - BE.

RATIFICATION AND IMPLEMENTATION DETAILS
STADE DE RATIFICATION ET DE MISE EN APPLICATION

* See overleaf reservations(*)/comments (+)
Voir au verso réserves (*)/commentaires (+)

RESERVES/RESERVATIONS

GERMANY	Every rocket of guided missile shall have an Ignition Safety Device. If this requirement cannot be met, a detailed hazard analysis shall be presented to the National Safety Approving Authority and the design shall be approved.
ALLEMAGNE	*Chaque roquette ou missile guidé devra avoir un dispositif de sécurité d'allumage. Si ce critère ne peut être respecté, une analyse de risque détaillée sera présentée à l'autorité nationale d'approbation concernant la sécurité et le modèle sera approuvé.*

COMMENTS/COMMENTAIRES

BELGIUM	The Organisations concerned do not have at their disposal the infrastructure and materiels required to carry out the tests prescribed in the STANAG.
BELGIQUE	*Les organisations concernées ne disposent pas des infrastructures et des matériels requis pour effectuer les tests prescrits par le STANAG.*
DANEMARK	*La ratification du Danemark est conditionnée par la ratification et la mise en application du STANAG par les principaux pays producteurs d'armes de l'OTAN.*
DENMARK	The Danish ratification is under the assumption that the major NATO weapon producing nations also ratify and implement the STANAG.

STANAG 4368
(Edition 2)

NAVY/ARMY/AIR

NATO STANDARDISATION AGREEMENT
(STANAG)

ELECTRIC AND LASER IGNITION SYSTEMS FOR ROCKETS AND GUIDED MISSILE MOTORS, SAFETY DESIGN REQUIREMENTS

Annexes: None

Related documents:

- for reference :

AOP-7	Manual of Tests for the Qualification of Explosive Materials for Military Use
STANAG 4147	Chemical Compatibility of Ammunition Components Explosives and Propellants (non-nuclear Applications)
STANAG 4157	Fuzing systems: test requirements for assessment of safety and suitability for service. (AOP-20)
STANAG 4170	Principles and Methodology for the Qualification of Explosive materials for Military Use. (AOP-7)
STANAG 4327	Lightning, Munition Assessment and Test Procedures

- for information :

STANAG 1307	Maximum NATO Naval Operational Electromagnetic Environment Produced by Radio and Radar
STANAG 2895	Extreme Climatic Conditions and Derived Conditions for Use in Defining Design/Test Criteria for NATO Forces Material
STANAG 2914	Mechanical Environmental Conditions to which Materiel intended for Use by NATO Forces could be exposed – (AECP-1)
STANAG 3525	Safety Design Requirements - Airborne Fuzing Systems
STANAG 4187	Fuzing Systems-Safety Design Requirements
STANAG 4234	Electromagnetic Radiation (Radio Frequency) 200 kHz to 40 GHz Environment Affecting the Design of Materiel for Use by NATO Forces
STANAG 4235	Electrostatic Environmental Conditions Affecting the Design of Materiel for Use by NATO Forces
STANAG 4236	Lightning Environmental Conditions Affecting The Design of Materiel for Use by NATO Forces
STANAG 4238	(Draft) Munition Design Principles, Electromagnetic Environment
STANAG 4240	Liquid Fuel Fire Tests for Munitions
STANAG 4241	Bullet Attack Tests for Munitions
STANAG 4297	Guidance on the Assessment of the Safety and Suitability for Service of Munitions for NATO Forces. (AOP-15).

AIM

1. The aim of this agreement is to standardise the safety design requirements for electrical and laser ignition systems for rockets and guided missile motors used in non-nuclear weapon systems.

AGREEMENT

2. Participating nations agree to design electrical and laser ignition systems for non-nuclear weapon rockets and guided missile motors in accordance with the requirements of this STANAG. This agreement is applicable to new developments initiated after promulgation.

DEFINITIONS

3. The following terms and definitions are used for the purpose of this agreement.

a. Electric Ignition. The activation of the initiator in the pyrotechnic train by direct application of electrical energy.

b. Firmware. Instructions fixed in the computer in "Read only" memory.

c. Igniter Charge. A source of heat and pressure that ignites the motor propellant.

d. Initiator. The first explosive component used in a pyrotechnic or explosive train.

e. Ignition Safety Device (ISD). A device whose purpose is to prevent unintended initiation of the rocket or guided missile motor by interruption of the ignition train, interruption of the laser energy or disconnection of the operating circuit.

f. Ignition System. The aggregate of devices involved in the control and generation of the operating signal to cause the rocket or missile motor to function.

g. Laser Ignition. The activation of the initiator by laser energy.

h. Ignition Train. The deflagration train beginning with the initiator and terminating in the igniter charge.

GENERAL

4. The Need for Design Safety Requirements.

a. Rocket and guided missile motor ignition systems perform functions critical to the safety of many weapon systems. Their inadvertent operation can result in serious risk to personnel and significant material damage. Inadvertent operation can be the result of direct initiation of the initiator by external stimuli, failure of ignition system control circuitry or human errors and can occur in all configurations and conditions found during storage, handling, operational use and disposal.

b. The increasing use of complex, software-controlled, fire control systems and the trend towards more “in-depth” testing of guided weapons adds a further need for design safety requirements.

DETAILS OF THE AGREEMENT

5. The following requirements shall be adhered to unless any deviation from them has been justified to, and accepted by, a National Safety Approving Authority (NSAA), and documented for reference by other participating nations:

a. Estimation of an Ignition Safety Device need.

(1) A preliminary hazard analysis must be conducted to determine the need of an Ignition Safety Device (ISD). For rockets and missiles with multi stage motors, the analysis shall include the evaluation of the need for an ISD for the second stage motor in order to provide protection to the launcher platform and personnel.

(2) A detailed analysis must be conducted to determine the weak points of the ignition system design and to have an estimate of the safety system failure rate. A detailed analysis of the contribution of the software to the design weakness and credible failures is also required.

(3) A detailed ignition system safety analysis shall be conducted, complemented by detailed hazard analyses using such methods as Fault Tree Analysis and Failure Modes, Effects and Criticality Analysis. The aim shall be to assess the risk of malfunction of the ignition system when used in its design role in all specified environments conditions and credible accident situations. The assessment should include an examination of the consequences of inadvertent ignition on the safety of the complete weapon system and a trade-off of safety and reliability.

(4) If there are no hazards or the hazards are acceptable, an ISD is not required. Otherwise, an ISD shall be fitted.

b. Design Safety requirements for electrical and laser ignition.

(1) The ignition system shall be designed to maintain the required degree of safety under all specified climatic, mechanical, and electrical environments associated with all configurations and in all operational modes of the weapon system as specified in the Manufacture to Target or Disposal Sequence (MTDS).

(2) An ignition system shall be designed to maintain accidental ignition probabilities of:

(a) Less than $1x10^{-6}$ during a long term storage.

(b) Less than $1x10^{-6}$ prior to the intentional initiation of the irreversible firing sequence.

c. Technological Recommendations for an ISD

(1) An ISD shall be designed to incorporate one or more of the following:

(a) A feature that prevents assembly of the ISD in an armed condition.

(b) A feature that provides a positive means of determining that it is not armed during and after its assembly and during installation into the munition.

(c) A feature that prevents installation of an armed, assembled ISD in a munition.

(2) If arming and reset of the assembled ISD in tests is a normal procedure in manufacture, inspection, or at any other time prior to its installation in a munition, sub-paragraph 5.c.(b) is not sufficient and sub-paragraph 5.c.(a) must also be met. The ignition system shall not be capable of being armed manually unless this is an operational requirement and is specifically approved by the NSAA. In this eventuality, the system shall be capable of being easily returned to safe condition under operational conditions.

(3) Subject to operational conditions, it should be possible at any time to determine the armed/unarmed status of the system. This facility shall not degrade safety levels.

(4) When the User requires pre-launch testing of munition function, other than that of the rocket motor ignition system, at least one safety feature of the ignition system shall be contained within the munition to disconnect the ignition circuit when the tests are carried out with personnel alongside. During munition testing and setting, the probabilities of accidental ignition given in paragraph 5.b.(2) shall be maintained even if there is an operator error. Safety shall not rely on defined operating procedures. Improper operating sequences shall be prevented by mechanical, electrical or optical interlocks.

(5) Safety functions

(a) During munition handling and operational use and before launch, it shall not be possible inadvertently to initiate the ignition train; safety shall not rely solely on defined operating procedures unless such a capability is an operational requirement. Improper operating sequences shall be prevented by mechanical, electrical or optical interlocks:

(i) To disconnect the ignition circuit.

(ii) To isolate until arming, pyrotechnic and explosive components which have not been qualified in accordance with par 5.c.(7) and which are more sensitive than the rocket motor propellant in the environments to which the munition will be subjected. (e.g. vibration, shock or heat).

(b) The ignition system shall be designed so that no single circumstance can result in ignition before valid enabling energy is available to the ignition system or to the ISD within the munition. This will require that the ignition system or the ISD contain at least two independent features, each of which shall prevent accidental ignition.

(c) The energy level required to operate the safety switches shall be the maximum possible. The signals used to operate the safety features shall be unique and dedicated.

(d) Firing and arming transmission lines shall be visually and physically separate from any other lines.

(e) When possible, the ISD should be equipped with a 'fail safe' system that will render the ignition system ineffective when safety of the system cannot be confirmed after a credible accident.

(6) Safety logic

Any logic features assuring safety contained within the munition ignition system shall be embedded in firmware or hardware. Design of the firmwave shall meet the requirements of the NSAA.

(7) Ignition train control

(a) Pyrotechnic and explosives. The pyrotechnic and explosives compositions, and materials used in the ignition system shall be chosen so that the system is safe and remains so under the specified conditions of storage and use. They shall be qualified in accordance with STANAG 4170/AOP-7 and AOP-15. Chemical compatibility shall be demonstrated in accordance with STANAG 4147; in particular, they shall be free from the risk of formation of unduly sensitive or dangerous compounds. Specific pass/fail criteria for the qualification of materials used in either interrupted or non-interrupted ignition trains shall be approved by a NSAA.

(b) Interrupted ignition train control. When the ignition train contain materials, other than those approved for use in non-interrupted ignition trains, at least one interrupter, e.g. shutter, slider, rotor, shall separate these materials from the remainder of the train.

(i) Each interrupter shall be directly locked mechanically in the safe position by at least one safety feature. The interrupter and its safety feature shall not be removed prior to intentional initiation of the arming sequence. They will be overcome by the arming energy and automatically return to a safe position, on removal of the arming energy.

(ii) If the ignition train contains a sensitive element which is positioned such that safety is dependent upon the presence of the interrupter, the design shall include positive means of preventing the ISD from being assembled without interrupter or with an improperly positioned interrupter.

(iii) If the sensitive element is positioned such that omission of the interrupter will prohibit ignition train transfer, e.g. igniter placed in the interrupter, only a positive means of preventing the ISD from being assembled with an improperly positioned interrupter is required.

(c) Non-interrupted ignition train control. When the ignition train contains only materials which have a sensitivity equal or less than the propellant used, the following shall apply:

(i) Functioning energy, i.e. energy capable of igniting the system, shall be controlled to preclude unintentional arming, and firing.

(ii) For ignition systems containing functioning energy prior to intentional arming, at least two energy interrupters, each controlled by an independent safety feature, shall prevent the flow of energy to the initiator until the intent to launch is verified by the ignition system.

(iii) When the design includes energy interrupters, the ignition system shall not be capable of functioning in the absence of or in the event of static failure of the interrupter(s).

(iv) The combined probability of having functioning energy in the ignition system, having a failure of the energy interrupter(s) and firing the initiator with the available functioning energy, shall be compatible with the allowable failure rates of paragraph 5.b.

(8) Electrical sensitivity levels

(a) The electrical sensitivity of the ignition train shall be the minimum required to initiate ignition reliably, or as near to it as is acceptable to the NSAA.

(b) For a non-interrupted ignition train, the electrical initiators shall not:

(i) Show unsafe degradation when tested in accordance with the appropriate STANAG covering such environments as e.g. ESD, Lightning

(ii) Be capable of being ignited by an electrical potential of less than 500V applied to any accessible part of the ISD during, or after, installation in the munition or any munition sub-system.

(iii) Be capable of being detonated by any electrical potential of less than 500V applied directly to the initiator.

(9) Connectors. Electrical connectors used in the ignition system shall have a unique configuration and be designed so that it impossible to connect them incorrectly.

d. Environmental tests. ISD safety functions will be tested in all configurations of the weapon system in which they are integrated, and in all the associated environmental conditions. The assessment of the safety and suitability for service of the ignition system shall be conducted in accordance with STANAG 4297/ AOP-15 and the STANAG 4157/AOP-20.

IMPLEMENTATION OF THE AGREEMENT

6. This STANAG is considered to be implemented by a nation when that nation has issued instructions that all future non-nuclear rockets and guided weapons entering service shall be designed in accordance with this agreement.